THE SCIENCE OF MANAGING AND USING WATER

Talk by Dr. Byron T. Shaw, Administrator, Agricultural Research Service, U. S. Department of Agriculture, at the dedication of the new Erosion Research Laboratory, Pullman, Washington, May 28, 1964.

It is a pleasure for me to be here today to dedicate this Erosion Research Laboratory. An occasion like this one is always satisfying for a research administrator.

Completion of this Laboratory, with its unique and specialized facilities, is the result of years of planning. Many people here in the Pacific Northwest have shared in this effort. If you had not, we would not be dedicating this building today.

We in the Agricultural Research Service have had a long and profitable association with the State universities and conservation groups of this area. We have enjoyed the cooperation of the Soil Conservation Service, your soil conservation districts, and many individual farmers and ranchers.

In the area of soil erosion research, we have worked with Washington State University for almost 35 years. One of the 10 original erosion research stations in the United States was established at Pullman in 1930. This laboratory is an expansion of that station.

Our partnership has helped to maintain and enhance the productivity of this important agricultural area, which harvests more than a tenth of the Nation's wheat crop annually.

Information developed through cooperative research at Pullman has long been the basis for soil management recommendations for this area. You are familiar with the studies on crop rotations, wheat-seeding methods, fertilizer practices, tillage, grasses and legumes, terracing, strip cropping, and waterway management.

Great as this progress has been, it has not been great enough. We must make our agriculture more profitable. We must make more intelligent use of our soil and water resources if our Nation is to remain strong.

Susceptibility to erosion, more than any other hazard, limits or prevents agricultural use of land in this country. Excess water, unfavorable soil, and adverse climate together do not restrict the use of as much land as erosion.

Nearly two-thirds of the Nation's cropland needs conservation treatment of some kind. The 37 percent where erosion prevention is the dominant conservation problem is an acreage roughly equivalent to the total land and water area of Washington, Oregon, and Idaho.

Erosion control is a continuing concern wherever land is periodically plowed, tilled, and planted. And erosion-control methods must be constantly updated and made compatible with new farming practices as they come into use.

The Palouse has a unique erosion problem. It requires unique facilities for its solution -- facilities we have for the first time at this laboratory.

As you know, the greatest soil loss here is associated with winter precipitation on wet, frozen, or partly frozen soil. These are different conditions from those we encounter in other parts of the Nation.

In the Middle West we expect the most erosion during spring or early summer rains, before crops form a protective cover over the soil. We also expect soil loss if the land is unprotected between harvest and freezing weather. In the South -- where the soil is seldom frozen very long if at all -- we know that unprotected fields will erode any time during the year.

Here, two-thirds of the annual precipitation occurs between October and March. Although the erosive force of the rainfall is usually relatively low, it comes before fall-seeded wheat has developed an erosion-restricting cover. The Palouse hills, where slopes may be as steep as 50 percent, are subject to high erosion rates whenever plant cover is inadequate.

We must have practical methods for farmers to use in stopping this erosion. That is why we need the detailed and fundamental studies this laboratory makes possible.

The scientists and engineers who designed this facility are to be congratulated on their originality and ingenuity. There's no other laboratory like it.

We can duplicate -- under controlled conditions -- most of the factors that contribute to runoff and soil erosion.

We can simulate rainfall -- anything from a light mist to a cloudburst. The height of the raintower permits most falling raindrops to approach terminal velocity, at which their erosive force is greatest, before striking the soil.

We can duplicate the steep slopes of the Palouse fields by tilting our test plot.

We can work with frozen or partly frozen soil. We can institute freezing of the soil from the top down as occurs in Nature, and we can thaw the frozen soil.

We can till the soil or establish various crop cover conditions.

We can control air and rainfall temperature.

We can simulate wind action. We can discharge air vertically from the tower's top to produce artificial rain without turbulence, or we can admit air from side ducts to simulate gusty wind.

Thus, we can reproduce the elements of the Palouse erosion problem -- rainfall, freezing slope, cover, temperature, and wind.

This is not the kind of laboratory familiar to many of us. We are accustomed to thinking of laboratory research as being on a very small scale -- small soil samples, a few plants, elaborate and complicated instrumentation.

Here at Pullman our soil scientists and agricultural engineers will be working with plots of soil 40 feet long and 8 feet wide. Just the same, the measurements will be as painstaking and precise as in any other laboratory.

The soil plot is contained in a specially built car that rolls on standard-gauge railroad tracks. The plot can be prepared outdoors or in an indoor working area and then be moved into the raintower for tests. The plot can be protected from natural rainfall in a covered storage area between tests.

The scientists will be working with a plot of soil that is similar in size to those used in field experiments. Like field plots, the soil in the car can be tilled or planted to crops. But we don't have to wait until winter and then hope the right set of erosive conditions develops for our experiments, as we must do in the field. We can test the effectiveness of experimental practices under precise conditions of our own choosing.

In a very real sense, this is a pilot plant. It bridges the gap between the laboratory and the field plot.

Our laboratory research has gained remarkable insight into soil and water management. Using soil samples, we have learned about the arrangement of soil aggregates, about the physical and chemical characteristics that make soils permeable or impermeable to water, and how water moves into and through soil.

Yet, translating our laboratory results to a field situation is difficult, and often frustrating. We develop useful leads working with small samples in the laboratory, but the results frequently cannot be reproduced under field conditions. Also, field research is very expensive.

This facility, which has characteristics of both the laboratory and the field plot, should advance our knowledge of erosion processes. A better understanding of these processes, gained by scientists at Pullman, will be shared with Federal, State, and industry research investigators throughout the country. Thus, the contributions of this laboratory will benefit the entire Nation.

The national erosion research effort of the Agricultural Research Service is carried on at about 25 locations, in cooperation with State agricultural experiment stations. It covers all facets of erosion, from the soil particles dislodged by a single raindrop to the tons of sediment moving in streams.

Our scientists are learning about the erosive force of the raindrop and the influence of drop size and the condition of the soil surface. They are delving into the mechanics of soil particle movement under thin films of water as runoff flows across a field surface. They are learning what properties of soil affect erosion, and how these properties can be modified by tillage. They are investigating the mechanics of erosion in small channels -- which are the beginning points of gullies.

A method of predicting how much of the dislodged sediment will reach our streams is the goal of other investigations. We are also interested in the reasons why some streambanks are more erodible than others. And we are seeking an understanding of the forces involved in sediment movement and deposition in stream channels.

We have made tremendous advances in the last 35 years.

Early efforts, including cooperative research here at Pullman, concentrated on the effects of soils, slope, and crops on runoff and erosion. Building on the basic information derived from these investigations, we have developed practices that are widely used today.

Our cooperative studies demonstrated the effectiveness of planting crops across the slopes or on the contour, instead of up and down the hills. They proved the usefulness of sod crops for holding the soil in place, and this led to the development of sod-based crop rotations. We have a uniform system of classifying soils, and basic information on the erodibility of individual soils. And now we can design cropping systems tailored to specific situations.

We have designed more elaborate methods of restricting soil loss in difficult situations.

We have learned how to build terraces to control runoff on steep and erodible slopes. The first terraces were narrow and hard to farm with large-scale machinery, but additional research developed the efficient broad-bench conservation terrace that is adapted to modern machinery.

We have learned how to design waterways to carry excess runoff from terraced or contoured fields, and how to establish and maintain a cover of grass on them.

We have developed recommendations for strip-cropping systems that are widely used in the Pacific Northwest and on the Northern Great Plains.

We have shown how to heal gullies and how to prevent new ones from forming.

We have devised ways of holding crop residues on or in the soil surface to restrict wind and water erosion during the interval between the harvest of one crop and the emergence and development of the next one. Stubble-mulch tillage and other conservation practices were born of the terrible dust storms of the 1930's. Farmers used these practices to reduce soil blowing by two thirds in the 1950's, when the Great Plains had drouth conditions as severe as those in the 1930's.

One of the most significant accomplishments in our rainfall erosion research has been a way of predicting soil loss. This is a technique with which we can help a farmer decide the best way to handle a field that is prone to erosion.

In the central and eastern States we can estimate fairly accurately the average annual soil loss in tons per acre from an individual field, under a specific rainfall pattern, crop management plan, and applied conservation practices. We can evaluate the erosion potential of alternate cropping plans and then recommend the one most likely to hold the valuable topsoil in place.

Unfortunatly, erosion prediction methods developed east of the Rocky Mountains don't fit the conditions in the Northwest. If we used those methods here, we would conclude that no significant erosion would occur. Even casual observation indicates to the contrary. Consequently, one of the important tasks of this laboratory will be to develop a prediction method that works here.

Hand in hand with erosion prevention must go wise and efficient <u>use</u> of our water resources.

The total water supply of the Pacific Northwest is abundant -- but poorly distributed. Annual precipitation ranges from well over 100 inches in the high mountains to as little as 4 inches in some of the interior valleys and basins.

Stream runoff from the Columbia River Basin is greater than from all remaining areas in the United States west of the Mississippi River. Each year about 183 million acre-feet of water enters the Pacific Ocean from the Columbia.

Understandably, this tremendous flow sometimes gets out of hand. This region is frequently plagued with floods when the snow melts in the mountains and foothills, as occurred in 1962 and in February of last year.

We need structures to detain and systematically release the spring runoff from the upland watersheds. But, before structures can be designed intelligently, we need basic hydrologic information.

Here are some of the questions to be answered:

How much water is in the snow cover? What is the water yield of the plateaus and foothill grazing areas? How soon, after snow begins to melt or rain starts falling, will the runoff reach a given point? What are the average and maximum amounts of runoff to be expected at the location where a dam is planned? How are average and peak flows affected by vegetation and land use?

Our hydrologic research watershed near Boise, Idaho, is seeking answers to these questions. It is one of four such installations, each serving a major physiographic area of the United States. Investigations at these and other localities are providing the facts needed for intelligent planning of upstream flood prevention and agricultural water management.

There have been a number of interesting developments from this research. One is the use of photography. We are using color photography in mapping vegetative cover, which must be determined before we can estimate runoff. And we are using aerial mapping in our studies of snow depth.

One of our major concerns is agriculture's use of water.

If the precipitation received in the continental United States were evenly distributed, all of our land would receive about 30 inches of rainfall each year. This is a tremendous resource.

But 70 percent of our precipitation is used in evapotranspiration from vegetated lands. Almost half of this is clearly an economic loss. This is the water used in evapotranspiration by such plants as sagebrush and willows.

The other half satisfies the evapotranspiration needs of cultivated crops, range and pasture plants, and forests. This generally contributes to the economic benefit of the Nation, provided good management practices are applied.

One of the challenges facing research lies in providing the sound practices that make the most efficient use of water for crop production.

Two examples will indicate the progress we have made in adapting crop production to limited moisture.

Our scientists in North Dakota produced 50 bushels of corn per acre, without irrigation, when only four inches of rain fell during the growing season. They accomplished this by ridging the area between the corn rows and covering the ridges with black plastic film. The rain drained off the plastic covering and concentrated around the plants. The row areas received the equivalent of a $2\frac{1}{2}$-inch rain from a quarter-inch shower on the field.

In another experiment, our scientists mixed a commercial alcohol product in the surface quarter inch of soil. It reduced the evaporation of moisture from the soil by 43 percent.

Neither of these methods is ready for general use by farmers. But they indicate the imagination our scientists are bringing to the search for new moisture-conservation methods.

Helping irrigated agriculture use water more efficiently is another of our goals. Nearly half of the water diverted from the Nation's streams is used for irrigation.

One of the biggest problems an irrigator faces is determining when to irrigate and how much water to apply. He must know which method of irrigation is most efficient for him. He must know how much water his soil can take up, and what the water needs of his crops are. If we can provide this information, we can help him stretch a limited water supply and avoid wasteful overirrigation.

An important contribution of our irrigation research has been a method of calibrating sprinkler irrigation systems, adjusting their output according to the water intake rate of the soil. We are also helping to lighten the irrigation farmer's work load, and increase his efficiency, with automated equipment for turning water into his fields and turning it off again when a predetermined amount has been applied.

In all of our work, it becomes increasingly apparent that the problems we face require very specialized facilities and great imagination on the part of our scientists.

In this Erosion Research Laboratory we have the specialized facilities to solve the unique erosion problems here in the Palouse. We have the competent leaders to direct and stimulate our staff. And soon we expect to have the laboratory fully manned with competent scientists and engineers -- men with the training and imagination to fully use the tools you have helped us provide. We believe we have a winning combination.

Let us dedicate this laboratory to all of you here in Washington and the Pacific Northwest whose foresight and hard work helped to make it possible. Let us dedicate it to continued progress in the conservation of our soil and water resources. Our stewardship of these resources will go a long way toward insuring the well-being and prosperity of future generations.

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